Часть 1

Олимпиада: **Физика, 11 класс (1 часть)**

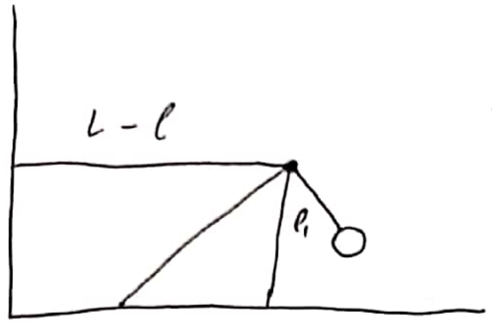
Шифр: **21200357**

ID профиля: **861910**

Вариант 4

Чистовик (1)

1)



$l_1 = l\cos\alpha$

$x_{мар} = L - l + l\cos\alpha$

$y_{мар} = -l\sin\alpha$

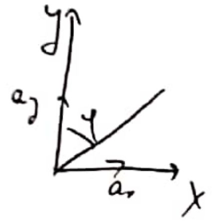
$\cos\alpha = \frac{8}{17}$

$\sin\alpha = \frac{15}{17}$

$tg\alpha = \frac{8}{15}$

$a_x = \ddot{x}_{мар} = \ddot{l}(\cos\alpha - 1)$

$a_y = \ddot{y}_{мар} = -\ddot{l}\sin\alpha$



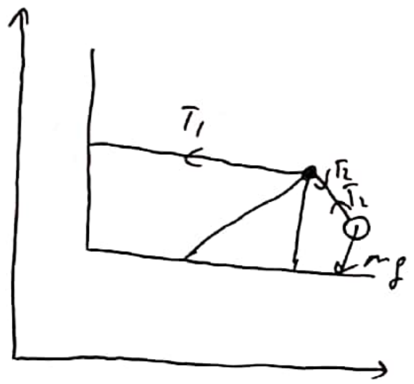
$tg\varphi = \frac{a_x}{a_y} = \frac{1-\cos\alpha}{\sin\alpha} = tg\frac{\alpha}{2} \Rightarrow$

1.1. →

$\Rightarrow tg\varphi = \frac{\frac{9}{17}}{\frac{15}{17}} = \frac{3}{5}$

Ответ $\frac{3}{5}$

1.2.



$a_x = -\frac{T_2}{m}\cos\alpha = a_y tg\varphi$

$a_y = \frac{T_2\sin\alpha}{m} - g = a_y tg\alpha\, tg\varphi - g \Rightarrow$

$\Rightarrow a_y = \frac{-g}{1 - tg\alpha\, tg\varphi} = -\frac{g}{1+\frac{8}{15}\cdot\frac{3}{5}} = \frac{25}{33}g$

$A_x = \frac{d^2}{dt^2}(L-l) = -\ddot{l} = \frac{a_y}{\sin\alpha} = \frac{17}{15}\left(-\frac{25}{33}g\right) = -\frac{85}{99}g$

Ответ $-\frac{85}{99}g$

1.3. Так, как трение отсутствует между верёвкой и блоком

$T_1 = T_2 \Rightarrow A_x = \frac{T_2(\cos\alpha - 1)}{M} = -\frac{m a_x(\cos\alpha - 1)}{M\cos\alpha} =$

$= \frac{m}{M} a_y \frac{tg\varphi(1-\cos\alpha)}{\cos\alpha} = \frac{m}{M} A_x\, tg\alpha\, tg\varphi(1-\cos\alpha) \Rightarrow$

$\Rightarrow \frac{m}{M} = \frac{1}{tg\alpha\, tg\varphi(1-\cos\alpha)} = \frac{1}{\frac{8}{15}\cdot\frac{3}{5}\cdot\frac{9}{17}} = \frac{425}{72}$

Ответ $\frac{425}{72}$

1) Чистовик (2)

1.4. $a_y = -\frac{25}{33}g = \frac{d^2H}{dt^2} \Rightarrow 0 - H = \frac{a_y \tau^2}{2} \Rightarrow \tau = \sqrt{\frac{66H}{25g}}$

Ответ $\sqrt{\frac{66H}{25g}}$

2) $\nu c dT = dU + PdV \quad dU = \frac{3}{2}\nu R dT$

2.1) $\Delta Q = \int \nu c dT = \int_{T_0}^{0{,}75T_0} \frac{9}{5} R\frac{T}{T_0} dT = \frac{9\nu R}{10 T_0}\left(\left(\frac{3}{4}\right)^2 T_0^2 - (T_0)^2\right) =$

$= -\frac{9}{10}\cdot\frac{7}{16}\nu R T_0 = -\frac{63}{160}\nu R T_0$

Ответ $-\frac{63}{160}\nu R T_0$

2.2. $A = \int PdV = \int \nu c dT - \int dU = \frac{9\nu R}{10 T_0}(T^2 - T_0^2) - \frac{3}{2}\nu R(T - T_0) =$

$= \frac{3}{2}\nu R(T - T_0)\left(\frac{3}{5}\left(1 + \frac{T}{T_0}\right) - 1\right)$

$A = \frac{3}{2}\nu R(T - T_0)\left(\frac{3}{5}\left(1 + \frac{T}{T_0}\right) - 1\right)$

$\frac{dA}{dT} = \frac{9}{5}\nu R\frac{T}{T_0} - \frac{3}{2}\nu R = 0 \Rightarrow T_{min} = \frac{3}{2}\cdot\frac{5}{9}T_0 = \frac{5}{6}T_0$

Ответ $\frac{5}{6}T_0$

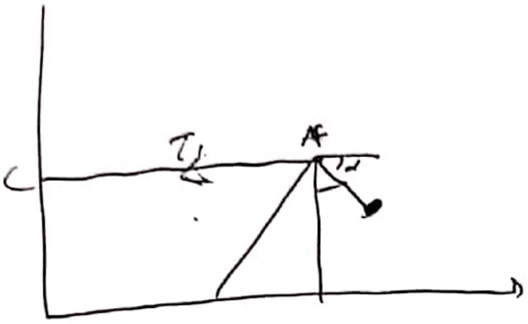
2.3 $A = \frac{3}{2}\nu R(T_{min} - T_0)\left(\frac{3}{5}\left(1 + \frac{T_{min}}{T_0}\right) - 1\right) =$

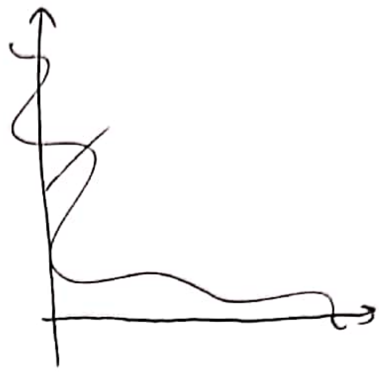
$= \frac{3}{2}\nu R\left(-\frac{1}{6}T_0\right)\left(\frac{3}{5}\cdot\frac{11}{6} - 1\right) = -\frac{1}{40}\nu R T_0$

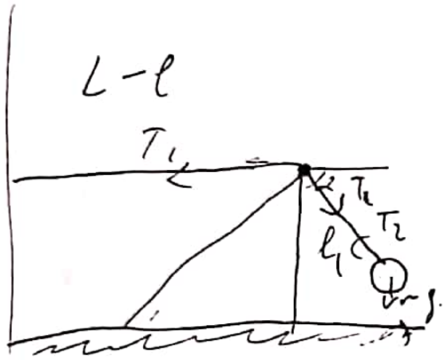
Ответ $-\frac{1}{40}\nu R T_0$

21200357 (U861910 M1264283)

Черновик







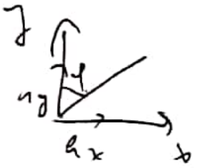
$l_1 = l\cos\alpha$

$x_{шар} = L - l + l\cos\alpha$

$y_{шар} = -l\sin\alpha$

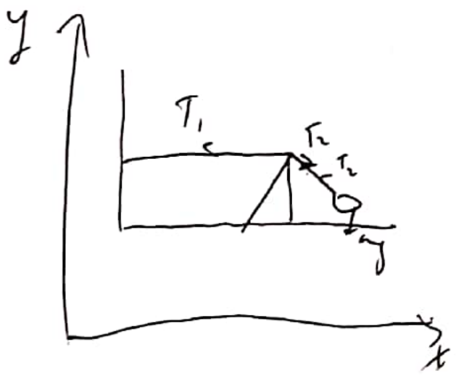
$a_x = \ddot{x}_{шар} = \ddot{l}(\cos\alpha - 1)$

$a_y = \ddot{y}_{шар} = -\ddot{l}\sin\alpha$



$$\operatorname{tg}\varphi = \frac{a_x}{a_y} = \frac{1-\cos\alpha}{\sin\alpha} = \operatorname{tg}\frac{\alpha}{2}$$

$$\operatorname{tg}\varphi = \frac{\frac{8}{17}}{\frac{15}{17}} = \frac{3}{5}$$



$$a_x = -\frac{T_2}{m}\cos\alpha = a_y\operatorname{tg}\varphi$$

$$a_y = \frac{T_2}{m}\sin\alpha - g = -a_y\operatorname{tg}\alpha\operatorname{tg}\varphi - g$$

$$a_y = \frac{-g}{1+\operatorname{tg}\alpha\operatorname{tg}\varphi} = -\frac{g}{1+\frac{8}{15}\cdot\frac{3}{5}} = \frac{25}{33}g$$

$$a_x = \frac{d^2}{dt^2}(L-l) = -\ddot{l} =$$

$$= \frac{a_y}{\sin\alpha} = \frac{17}{15}\cdot\left(\frac{25}{33}g\right) = -\frac{85}{99}g$$

Перрметик

$$A_x = \frac{T_2(\cos\alpha - 1)}{m} = \frac{-mg_x(\cos\alpha-1)}{m\cos\alpha} = \frac{m}{M} g \frac{\operatorname{tg}\varphi(1-\cos\alpha)}{\cos\alpha} =$$

$$= \frac{m}{M} A_x\, g\,\alpha\operatorname{tg}\varphi(1-\cos\alpha) \Rightarrow \frac{m}{M} = \frac{1}{g\alpha\operatorname{tg}\varphi(1-\cos\alpha)} =$$

$$= \frac{1}{\frac{8}{15}\cdot\frac{8}{5}\cdot\frac{9}{17}} = \frac{425}{7^2}$$

$$a_y = \frac{25}{77} g = \frac{d^2 H}{dt^2} \Rightarrow (0-H) = \frac{a_y t^2}{2} \Rightarrow t = \sqrt{\frac{66H}{47}}$$

$$\nu c\, dT = dU + p\,dV \qquad dU = \frac{3}{2}\nu p\,dT$$

$$p = \frac{\nu RT}{V}$$

$$\Delta Q = \int \nu c\, dT = \int_{T_0}^{0{,}75T_0} \frac{9}{5}\nu R\frac{T}{T_0}\,dT = \frac{9\nu R}{10T_0}\left(\left(\frac{3}{4}\right)^2 T_0^2 - T_0^2\right) =$$

$$= -\frac{9}{10}\cdot\frac{7}{16}\nu R T_0 = -\frac{63}{160}\nu R T_0$$

$$A = \int p\,dV = \int_{T_0}^{T}\nu c\,dT - \int_{T_0}^{T} dU = \frac{9\nu R}{10T_0}(T^2 - T_0^2) -$$

$$-\frac{3}{2}\nu R(T-T_0) = \frac{3}{2}\nu R(T-T_0)\left(\frac{3}{5}\left(1+\frac{T}{T_0}\right)-1\right)$$

$$\frac{dA}{dT} = \frac{9}{5}\nu R\frac{T}{T_0} - \frac{3}{2}\nu R \Rightarrow T_{max} = \frac{3}{2}\cdot\frac{5}{9}T_0 = \frac{5}{6}T_0$$

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Черновик

$$A = \frac{3}{2}\nu R\left(T_{n,2} - T_0\right)\left(\frac{3}{5}\left(1 + \frac{T_{n,2}}{T_0}\right) - 1\right) = \frac{3}{2}\nu R\left(-\frac{1}{6}T_0\right)\left(\frac{3}{5}\cdot\frac{11}{6} - 1\right) =$$

$$= -\frac{1}{40}\nu R T_0$$

Часть 2

Олимпиада: **Физика, 11 класс (2 часть)**

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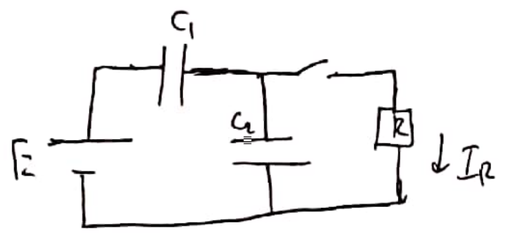
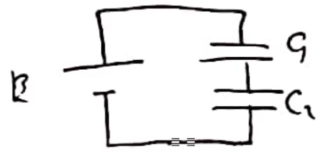
Вариант 4

Чистовик (3)

3)





~~Так~~ Это до замыкания цепи

$$q_0 = q_1 = q_2 \Rightarrow \frac{q_0}{C} + \frac{q_0}{5C} = E \Rightarrow q_0 = \frac{5}{6} EC$$

3.1) После замыкания напряжение на конденс резистора равно

$$U_{C_2} = \frac{q_0}{C} = \frac{5}{6} E \Rightarrow I_0 = \frac{5}{6} \cdot \frac{E}{R}$$

Ответ $\frac{5}{6} \cdot \frac{E}{R}$

3.2)
$$\begin{cases} E - \frac{q_1}{C_1} - I_R \cdot R = 0 \\ I_R \cdot R = \frac{q_2}{C_2} \\ I_R = \frac{dq_1}{dt} - \frac{dq_2}{dt} \end{cases} \Leftrightarrow \begin{cases} E - \frac{q_1}{5C} - \frac{q_2}{C} = 0 \\ \frac{d(q_1 - q_2)}{dt} = \frac{q_2}{RC} \end{cases} \Leftrightarrow$$

$$\Leftrightarrow \begin{cases} q_1 = 5CE - 5q_2 \\ \frac{d(-6q_2)}{dt} = \frac{q_2}{RC} \end{cases}$$

$$q_2 = q_0 \exp\left(-\frac{t}{6RC}\right) \Rightarrow q(t \to \infty) = 0$$

$$q_1 \longrightarrow 5CE$$

$$E \cdot (5CE - q_0) + \frac{q_0^2}{2C_1} + \frac{q_0^2}{2C_2} = \frac{(5CE)^2}{2C_1} + Q \Rightarrow$$

$$\Rightarrow Q = \frac{25}{12} E^2 C$$

Ответ $\frac{25}{12} E^2 C$

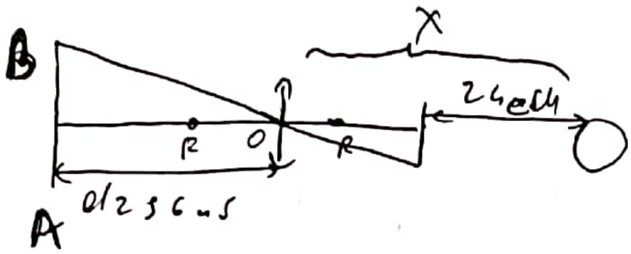
Чистовик (4)

3.3. $\frac{dq_2}{dt} = -\frac{q_0}{6RC}\exp\left(-\frac{t_0}{6RC}\right) = -I_0$

$I_R = -6 \cdot \frac{dq_2}{dt} = 6I_0$ //

Ответ $6I_0$

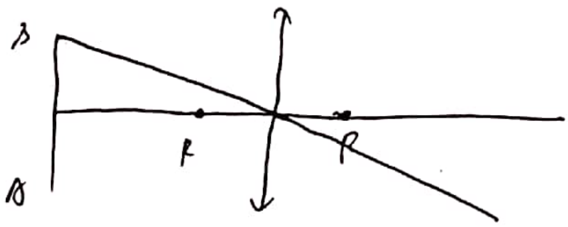
5)



5.1 $\frac{1}{d} + \frac{1}{l} = \frac{1}{F} \Rightarrow l = \frac{dF}{d-F} = 32см \Rightarrow x = l + 24 = 56 см$

ответ 56 см

5.2



$BM = h = H \cdot \frac{l}{d} = H \cdot \frac{F}{d-F}$

$BM = \frac{FH}{d-F} = 3см$

Ответ 3см

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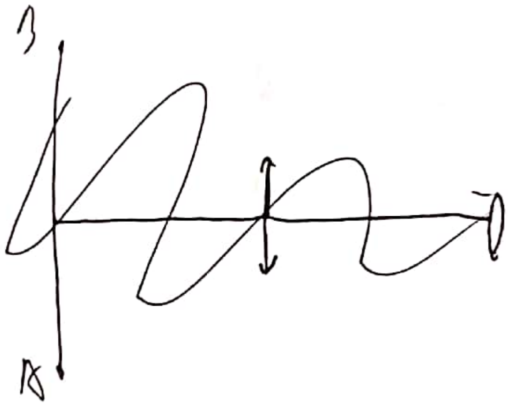
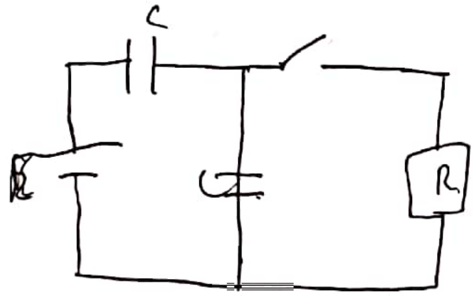
Черновик





$q_0 = q_1 = q_2$

$E = \frac{q_0}{C} + \frac{q_0}{5C} = \frac{6q_0}{5C}$

$q_0 = \frac{5EC}{6}$

$U_C = \frac{q_0}{C} = \frac{5}{6}E \Rightarrow I_0 = \frac{5E}{6R}$

$E - \frac{q_1}{C_1} - I_R \cdot R = 0$

$I_R \cdot R = \frac{q_2}{C_2}$

$I_R = \frac{dq_1}{t} - \frac{dq_2}{dt}$

$\frac{dq_2}{dt} = \frac{-q_0}{6RC}\exp\left(\frac{t_0}{6RC}\right) = -I_0$

$I_R = 6 \cdot \frac{dq_2}{dt} = -6I_0$

$\frac{q_2}{C_2} = \frac{d(q_1 - q_2)}{dt} \Rightarrow \frac{d(-6q_2)}{dt} = \frac{q_2}{RC}$

$E: \; E - \frac{q_1}{C_1} - \frac{q_2}{C_2} = 0 \Rightarrow q_1 = 5CE - 5q_2$

$\frac{dq_2}{dt} = \frac{-q_0}{6RC}\exp\left(\frac{t_0}{6RC}\right) = -I_0$

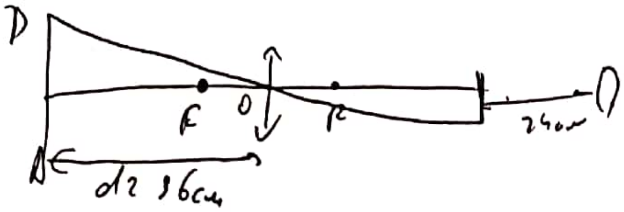
$q_2 = q_0 \exp\left(-\frac{t}{6RC}\right) \Rightarrow q_2(t \to \infty) = 0$

$q_1 \to 5CE$

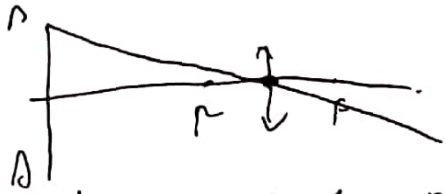
$E \cdot (5CE - q_0) + \frac{q_0^2}{2C_1} + \frac{q_0^2}{2C_2} = \frac{(5CE)^2}{2C_1} + Q \Rightarrow I_R = -6\frac{dq_2}{dt} = 6I_0$

$\Rightarrow Q = \frac{25}{12}E^2C$

Черновик



$$\frac{1}{d} + \frac{1}{l} = \frac{1}{F} \Rightarrow l = \frac{dF}{d-F} = \frac{96\cdot 24}{72} = 32 \quad 256$$



$$D_m = h = H\cdot\frac{l}{d} = \frac{FH}{d-F} = \frac{24\cdot 9}{72} = 3$$